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ECOLOGY AND SOCIAL STRUCTURE OF *HYPOGEOMYS ANTIMENA*, AN ENDEMIC RODENT OF THE DRY DECIDUOUS FOREST IN WESTERN MADAGASCAR

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ABSTRACT.- The geographic range of *Hypogeomys antimena*, the largest endemic rodent of Madagascar, was recently restricted to the dry deciduous forest of Western Madagascar. Between 1992 and 1995 collected capture/re-trapping and telemetry data indicate that the rodent lives in a monogamous social system. Range size is determined by the season, presence of offspring and the occurence of the main predator *Cryptoprocta ferox.*

KEY WORDS.- Ecology, Social structure, Endemic rodent, *Hypogeomys antimena*, Madagascar

RESUME.- La répartition géographique d'*Hypogeomys artimena*, le plus gros rongeur endémique de Madagascar, a été récemment limitée aux forêts sèches caducifolées de l'ouest de Madagascar. Entre 1992 et 1995 des méthodes de capture/repiégage et de télémétrie ont permis l'assemblement des données indiquant que ces rongeurs vivent dans un système social monogame. L'importance du rayon de dispersion est déterminé par la saison, la présence d'une portée et par l'occurance du prédateur principal, *Cryptoprocta ferox.*

MOTS-CLES.- Ecologie, Structure sociale, Rongeur endémique, *Hypogeomys antimena*, Madagascar

INTRODUCTION

Hypogeomys antimena Grandidier, the Malagasy Giant Jumping Rat, is the largest endemic rodent of Madagascar. The herbivorous rodent is strictly nocturnal and spends the day in long deep burrows. The facts so far known about its biology like pair bonds, 1-2 offspring per year, lack of sexual dimorphism and the results of a nine-week trapping and radiotracking field study (COOK, TREVELYAN, WALLS, HATCHER & RAKOTONDRAPARANY, 1991) are typical characteristics of monogamy, a rare social system occuring only in 3% of mammals. By using the methods of mark/re-trapping and radio-telemetry during different seasons investigations in the proposed social system and the ecology of *Hypogeomys antimena* were carried out.

DISTRIBUTION

The modern distribution of *Hypogeomys antimena* is restricted to the narrow coastal zone of dry deciduous forest, no more than 1000 km² between the rivers Andranomena and Tsiribihina (Fig. 1). However, paleontological evidence indicates that

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during the Quaternary *Hypogeomys antimena* had a much broader geographical range on the island and that the genus consisted of at least two species (GOODMAN & RAKOTONDRAVONY, in press).

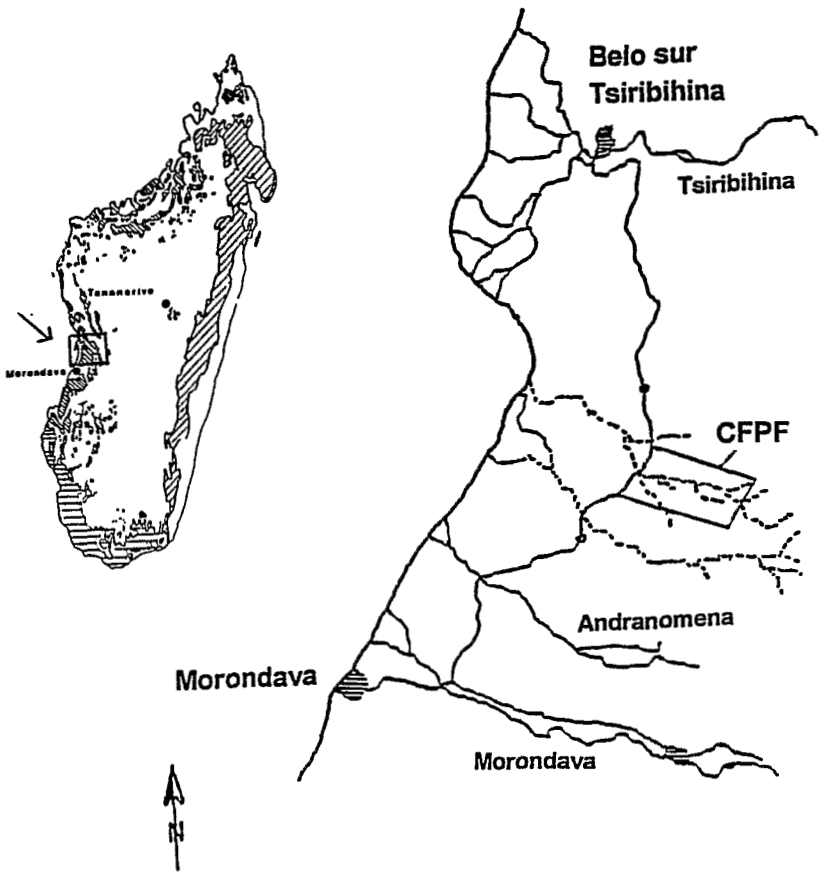

Fig. 1. Recent distribution of *Hypogeomys antimena* at the western coast of Madagascar between the rivers Andranomena und Tsiribihina. Location of the study site on the forestry concession of the Centre de Formation de Morondava (CFPF). Scale 1:500 000.

METHODS

The field work took place between October 1992 and January 1993, February and April 1994, March and June 1995. The study area was 2500m x 400m in 1992 and 1994. This area was increased by another 700m x 900m in 1995. A grid system was established as reference. Burrows of *H. antimena* were initially located by systematic search. At least two Tomahawk Live Traps, (51cm x 19cm x 19cm, Tomahawk, Wisconsin) were placed in front of all holes of a burrow for several nights till no more new animals were trapped. Captured animals were anaesthetized, sexed, weighed, measured and individually marked by ear-tattoos or passive integrated transponders. Further blood samples were taken for genetic work. Up to 19 animals from neighbouring burrows were fitted with radio-collars. Throughout the whole nocturnal activity period of the rodents each animal was

located once per hour in 4-5 consecutive nights per month. Range size, shape, and overlap were analyzed by minimum-convex-polygon technique.

RESULTS AND DISCUSSION

1) SOCIAL STRUCTURE

a) Morphological correlates

Between October 1992 and June 1995 a total of 115 different animals was trapped in 28 burrows. There were no significant sex differences in the ratio and body measurements (Table I). The relative testis size (length of a single testis divided by male body length) was compared with the results of 16 other rodent species with respect to their mating system (HESKE & OSTFELD, 1990) and can be considered as small. The combination of no sexual dimorphism together with small testes is characteristic for a monogamous social system.

b) Pair bonding and parent/offspring bonding

There-trapping data of some burrows that were investigated and active since October 1992 are presented in Table II. The other burrows show similar patterns. The re-trapping data indicate

1) Burrows are inhabited either by pairs or families (male, female, subadult and/or juvenile). If an additional animal with adult weight is present, normally it is not yet reproductive. These animals often could be trapped in another burrow during the following re-trapping period (*e.g.* B6: 05R, 03L; B8: 39R; B14: 04L).

2) Pair bonds might continue for more than one reproductive season. Male and female of B8, B9, B11 were still in the same pairs and remained associated during both breeding and non-breeding periods.

3) Changes in the pair bonds and high « turn-over » rate of burrows might be explained by the high predation rate (see 2c).

4) Offspring show a delayed dispersal. They stay together with their parents for at least one more reproductive period (*e.g.* B8: 39R; B9: 08L) and seem to leave in the third year (*e.g.* B8: 39R, 180m). Sexual maturation is probably not reached before the age of two years.

5) Migration distance was between 120m and 400m (248m ± 119m, n=9)

c) Spatial distribution

The radiotracking data show that males and females from neighbouring burrows have similarly sized but mutually exclusive home ranges. Home ranges of burrow mates however overlapped in every night extensively. Ranges of subadults are smaller and within the ranges of the parents (Fig. 2).

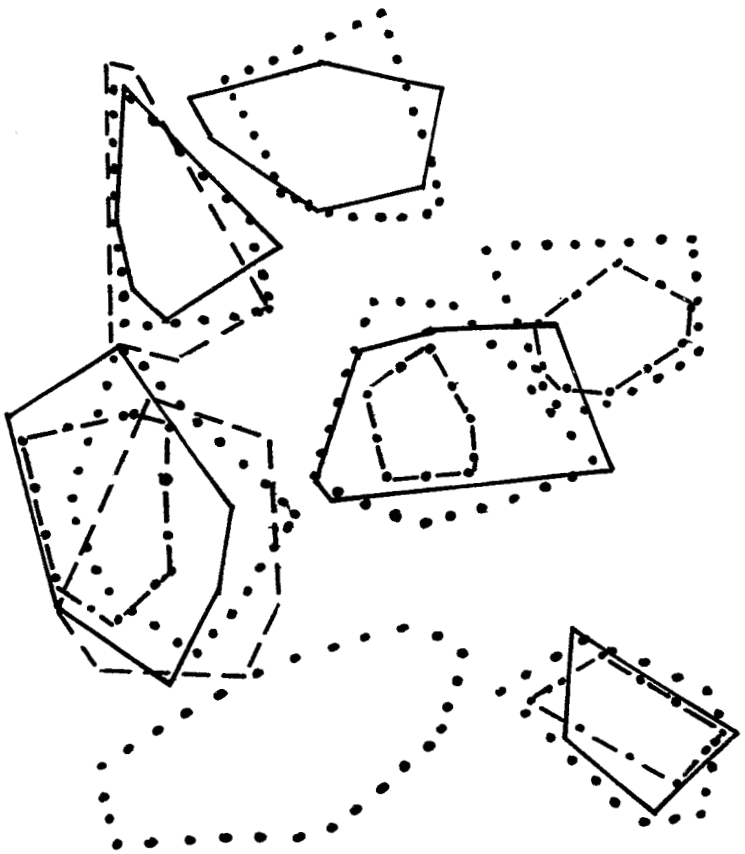

Fig. 2. Example of the distribution of total home ranges of adult males _____, adult females °°°°°°, females (previous offspring, still in the natal burrow) ------, subadults -°-°-° of 7 neighbouring burrows in April 1995. Scale 1:50.

2) DETERMINATION OF HOME RANGE SIZE

The size of the home ranges is determined by different factors:

a) Dry season - rainy season

During the dry season in October before offspring were born, home ranges were larger than during the rainy season (November, December) after birth of the young (Fig.

3). The larger home ranges during the dry season could be explained by the scarcity of food (fruits, leaves, young shoots) and the lower protein content of fruit.

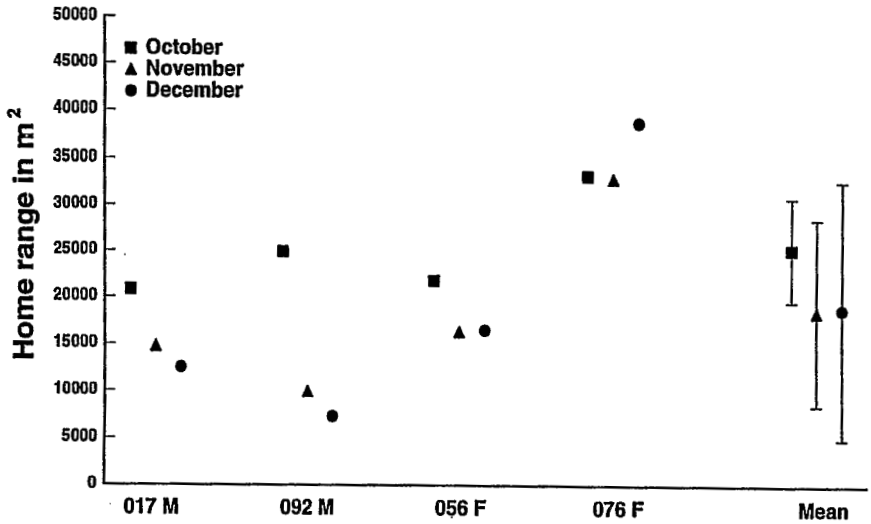

Fig. 3. Total home ranges (in m²) during the dry (Oct) and the rainy season (Nov, Dec). On the abscissa the radiocollar-numbers of the individuals, the sex and the mean (± StD) of the 4 animals that were radiotracked during the whole period are given.

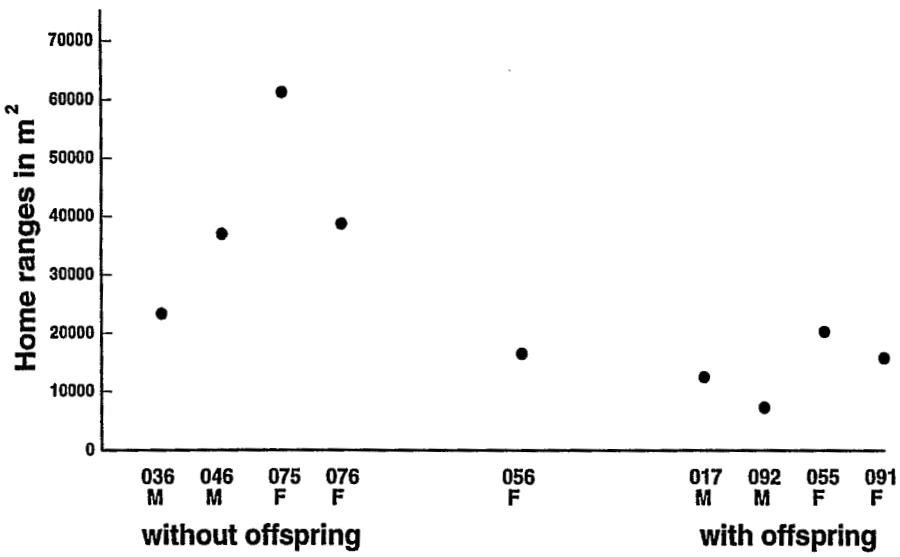

Fig 4. Total home range (in m²) of animals with and without offspring in December. On the abscissa the radiocollar-numbers of the individuals and the sexes are given.

b) Presence of offspring

Birth season of *Hypogeomys* starts with the onset of the hot rainy season (end of November). In December animals with young used significantly smaller areas than animals without offspring (Fig. 4, t= -3.13, p=0.02). In the case of female 056 the reproductive state was unclear but telemetry data suggest presence of an offspring. The

defendability of the home range is a necessary condition to detect potential intruders. It depends on the ability of an animal to monitor the boundaries with sufficient frequency and depends therefore on the size of the range (MITANI & RODMAN, 1979). Reduction of the home range size after birth of offspring and the resulting increase in defend ability might be an adaption to protect the offspring.

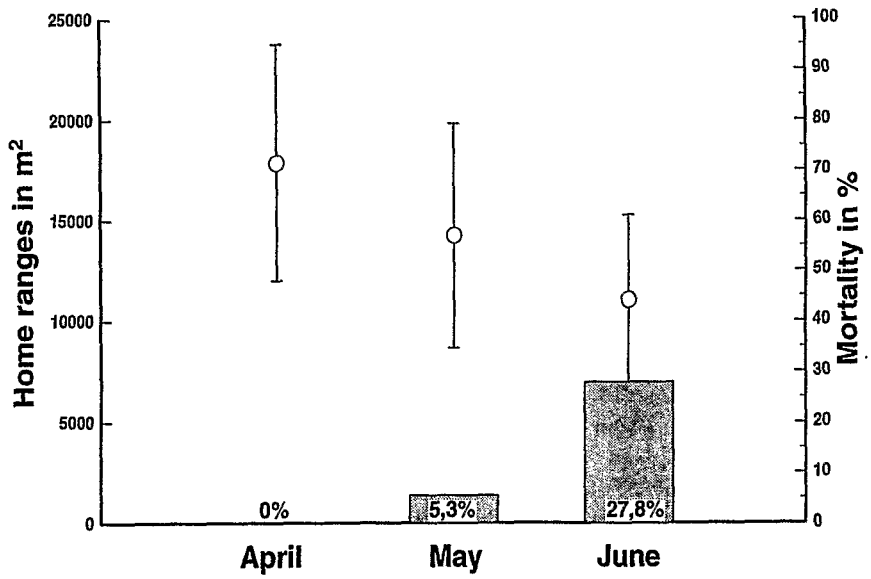

Fig. 5. Total home range (Mean ± StD in m², left ordinate) and mortality caused by *Crypoprocta ferox* (in %, right ordinate) between April and June 1995. In addition one animal was eaten by the boa (*Acrantophis spec.)*

c) presence of the main predator *Cryptoprocta ferox*

If *Cryptoprocta ferox* is present faeces can easiliy be found on the pistes and in the grid system. Three persons found independently fresh faeces and/or have seen an animal first time this year on 25th April 1995 in different parts of the study area. First *Hypogeomys*-radiocollar with the characteristic biting signs was found on 26th April 1995. *Hypogeomys* significantly reduces its home range after the arrival of the main predator (Fig. 5, Friedman two-way analysis of variance, $P<0,01$, $n=12$).

CONCLUSIONS

1) *Hypogeomys* lives in a **monogamous** social system. This is indicated by the morphological correlates (lack of sexual dimorphism, small relative testis size) and the results of capture/recapture and radio-tracking. Pair bonds might continue for more than one reproductive season. The only 1-2 offspring/pair/year show a delayed dispersal and late sexual maturity. The home ranges of males and females are mutually exclusive and only burrow mates have overlapping home ranges.

2) Home range sizes are first determined by the season. They are larger during the dry season than during the rainy season. Further range size is determined by the presence

of offspring. Animals without offspring have larger ranges than animals with offspring. In addition the presence of the main predator *Cryptoprocta ferox* has a main impact on ranging behaviour. The range sizes are reduced in relation to increasing predation mortality.

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Table I. Examples of the body measurements of adult *Hypogeomys antimena* (Mean ± StD).

	Males	**Females**	
Body mass (kg)	1.11 ± 0.11 (N=19)	1.12 ± 0.12 (N=25)	n.s
Body length (cm)	30.41 ± 1.28 (N=17)	30.30 ± 1.48 (N=21)	n.s
Tail length (cm)	22.59 ± 1.68 (N=19)	23.30 ± 1.27 (N=25)	n.s
Ear length (cm)	6.10 ± 0.46 (N=19)	6.00 ± 0.35 (N=25)	n.s
Hindfoot length (cm)	7.31 ± 0.24 (N=18)	7.32 ± 0.18 (N=24)	n.s

Table II. Re-trapping data 1992 - 1995. For each animal the number of the ear-tattoo (R= marked in 1992, L= marked in 1994, T= marked in 1995), the sex (F= female, M= male) and the age (Ad= adult, Ad# = adult weight, but not yet reproductive, SA= subadult, Juv= juvenile) are given. *= re-trapped in the same burrow as in the previous year. += re-trapped in a different burrow, x= dispersal/migration untill the following re-trapping period.

Burrow-Code	December 1992				March 1994				April - June 1995			
B1	54R	F	Ad		13L	F	Ad		01T	M	Ad	
	59R	M	Ad		59R	M	Ad	*				
					16L		SA					
					15L		Juv					
B4	45R	F	Ad		05R	F	Ad	+	39R	F	Ad	+
	47R	M	Ad						02T	M	Ad	
B6	48R	F	Ad		48R	F	Ad	*	03T	F	Ad	
	50R	M	Ad		06L	M	Ad		06L	M	Ad	*
	05R	F	Ad	x	03L	F	Ad	x				
					07L	M	SA					
B8	23R	F	Ad		23R	F	Ad	*	23R	F	Ad	*
	20R	M	Ad		20R	M	Ad	*	04T	M	Ad	
	39R		Juv		39R	F	Ad#	* x				
	40R		Juv		02L	M	Ad#					
B9	19R	F	Ad		19R	F	Ad	*	19R	F	Ad	*
	17R	M	Ad		17R	M	Ad	*	17R	M	Ad	*
	15R	M	Ad		08L		Juv		08L	F	Ad#	*
									05T	M	SA	
									06T		Juv	
B11	38R	F	Ad		38R	F	Ad	*	38R	F	Ad	*
	24R	M	Ad		24R	M	Ad	*	24R	M	Ad	*
					17L	M	Ad		07T	F	SA	
					18L		SA		08T	F	SA	
B12	12R	F	Ad		14L	F	Ad		14L	F	Ad	*
	06R	M	Ad		20L	M	Ad		30L	M	Ad	+
	46R		Juv		21L		Juv		09T	F	SA	
									10T		Juv	
B14	10R	F	Ad		10R	F	Ad	*	10R	F	Ad	*
	08R	M	Ad		04L	F	Ad		11T	M	Ad	
									04L	F	Ad	* x
									12T		Juv	